Audubon Naturalist Society * Chesapeake Bay Foundation
Coalition for Smarter Growth * Environmental Defense
Piedmont Environmental Council * Solutions Not Sprawl

November 4, 2002

The Honorable Phil Mendelson
Chairman, Metropolitan Washington
Planning Board
777 N. Capitol St. NE #300
Washington, DC 20002

The Honorable Kate Hanley,
Chair, Metropolitan Washington Transportation
Air Quality Committee
777 N. Capitol St. NE #300
Washington, DC 20002

Re: Effects of Proposed Potomac River Crossings on Land Use and Traffic and Identification of Serious Deficiencies in TPB Version 2 Transportation Model

Dear Mr. Mendelson and Ms. Hanley:

We are submitting to TPB and MWAQC and other relevant committees and officials in the metropolitan Washington region the attached report, *More Sprawl, More Traffic, No Relief: An Analysis of Proposed Potomac River Crossings*, released last week by the Audubon Naturalist Society of the Central Atlantic States, Chesapeake Bay Foundation, Coalition for Smarter Growth, Environmental Defense, Piedmont Environmental Council, and Solutions Not Sprawl. This report includes an *Executive Summary* and a transportation-focused *Technical Report*, which critiques the TPB Version 2 traffic model, along with the land use technical report, *Analysis: Impact on Land Use of a North Potomac River Crossing*. All of these are attached and submitted for you consideration.[1]

An Expert Independent Real Estate and Transportation Modeling Analysis Shows New River Crossings Would Exacerbate Traffic and Pollution Problems. This report - prepared by Smart Mobility, Inc. and Anita Kramer Associates, Inc.- concludes that proposed new Potomac River crossings and expressways connecting northern Virginia with Montgomery or Frederick County, Maryland, would spur sprawl, traffic, and pollution growth and would reduce traffic on the American Legion Bridge by less than two percent. The Techway and Western Transportation Corridor (WTC) were found to significantly increase traffic and worsen congestion across large parts of Montgomery, Frederick, and northern Virginia counties.

Utilizing sophisticated real estate market data and a refined version of the latest Council of Governments regional traffic model, the consultants determined the land use and transportation effects of two proposed crossings that are components of proposed outer beltways. We urge you to consider these findings as you consider significant proposals to construct outer suburban road projects, including new bridge and outer beltway connections.

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[1] The Executive summary is also available at: http://www.environmentaldefense.org/article.cfm?ContentID=2386, with technical reports at: http://www.environmentaldefense.org/documents/2384_TechwayTechnicalReport.pdf, and http://www.environmentaldefense.org/documents/2388_NPotomacLandUseStudy.pdf

Techway or Western Transportation Corridor: Everbody Loses. This study demonstrates that everybody loses if the Techway or WTC are built. Commuters stuck in traffic on the American Legion bridge stay stuck in traffic, and residents near these bridge corridors will face worse traffic and the loss of even more rural land. It is bad public policy to spend billions of dollars to build new bridges that will make congestion worse, stimulate the development of our rural areas and watersheds, and spur the decline of our existing communities and infrastructure.

As the saying goes, "If you build it, they will come," in the form of more development and traffic in the outer areas at the expense of the region's core and Prince George's County. Our consultants found that the Techway bridge would provide no noticeable traffic relief to motorists now stuck in traffic. Traffic on roads near the new bridges would be significantly higher than it would be without the bridges. For example, with the Techway, traffic on Route 7 in Virginia adjacent to a new interchange would almost double compared to the No Build scenario. Traffic on Maryland Route 28 would nearly triple compared to the No Build scenario. These results confirm findings from a Virginia Department of Transportation analysis as part of the Northern Virginia 2020 Transportation Plan and by Montgomery County in its Transportation Policy Report.

WTC and Techway: Fueling Traffic and Pollution Growth. In fact, as the table below shows, Vehicle Miles of Travel (VMT) would increase significantly with construction of either the Techway or the WTC, compared to a 2025 no-build scenario, spurring parallel increases in pollution and greenhouse gas emissions to the detriment of the environment and public health:

	Increase in VMT Compared to 2025 No-Build	
County	**With WTC**	**With Techway**
Montgomery	9%	13%
Frederick	2%	1%
Loudoun County	11%	6%
Prince William	3%	3%
Fairfax	1%	5%
Fauquier	1%	1%
Regional Total	1.3%	1.5

It's simple: a new bridge and associated highways will shift land use and traffic and spark increased congestion in many parts of the region. The scattered new development for up to 85,000 new households and 252,000 jobs in the six counties, spurred by the new bridges(s) and highway(s), comes at the expense of communities with good transit services and shorter average trip lengths, increasing the number of vehicle trips and trip lengths, and exacerbating existing environmental problems, such as air and water pollution.

Western Transportation Corridor and Techway: Major Sprawl Generators that Put Core and Inner Suburban Economic Vitality At Risk. A companion analysis of demographic changes finds that all bridge alternatives will result in significant increases in development by 2025 over the current regional forecasts for Loudoun, Fairfax, Prince William, and Fauquier Counties in Virginia and Montgomery and Frederick Counties in Maryland. In fact, either of the bridges will cause an explosion of growth and undermine efforts by Montgomery, Loudoun and Frederick to protect rural areas. This study confirms the Council of Government's previous findings regarding the I-270 expansion. Following the expansion of I-270 from six to 12 lanes in the late 1980's, traffic improved briefly, but was followed by a boom in development. Under Montgomery County's growth management law, planners were forced to immediately relax the corridor's subdivision growth limits to allow up to12,000 additional homes and 13,000 more jobs. By 1997, I-270 routinely exceeded its design capacity, and peak hour traffic volume on some segments surpassed 2010 forecasts. The *Briefing Paper for the National Capital Region Transportation Planning Board on Induced Travel*[2] recognized that the higher volumes on I-270 relative to the forecasts "appear to be due in large part to shifts in population, employment, and travel to the I-270 corridor from other areas in the region." Our new consultant study confirms that the Techway and the Western Transportation Corridor would have the same effect. Construction of these roads would likely shift population and employment from core areas of DC, Alexandria, Arlington and Prince George's County.

Critical Deficiencies in TPB Version 2 Model That Must Be Remedied. As part of this study, our transportation consultant reviewed the TPB Version 2.0 Model released in July 2002 and found a number of critical deficiencies. These are discussed in detail in the attached *Technical Report* and summarized below. When the Version 2 model base year simulation is compared with observed travel behavior data for the region, the new TPB model is found to predict too many trips and these are on average too short. The Version 2 model makes excessive use of "K-factors" to help the model better match observed traffic counts, but these significantly reduce the model's capacity to represent induced traffic effects of road expansion proposals and to represent the traffic reduction benefits of Smart Growth strategies. Despite these adjustment factors, the model still over-predicts 1994 total daily base year Potomac River crossing vehicle trips and total traffic volumes, by 22 percent and 14 percent respectively for Version 2.1 (which is even worse than for Version 2.0). Although non-work trips make up the majority of travel in the AM and PM peak travel periods, the Version 2 model considers the effects of congestion only on work trips. This further diminishes the model's capacity to fairly evaluate the effects of road capacity expansion vs. Smart Growth strategies and to reflect induced traffic effects.

Thus, like the TPB Version 1 travel demand model, Version 2 will overestimate motor vehicle travel demand in the future and overestimate the benefits of proposed highway improvements. Moreover, from the latest documentation available,[3] it appears that the Version 2.1 model overestimates 1994 and 2000 AM and PM peak period traffic volumes – by 14 to 29 percent across an average of all permanent count stations. The overestimation is particularly acute for vehicles entering or leaving the Metro Core, where PM peak trips are overestimated by 52 percent in 1994 and by 40 percent in 2000. This is yet one more reflection of consequences of the failure of the TPB Version 1 and Version 2 models to properly incorporate congestion feedback in the modeling process as required by federal planning regulations (CFR Title 40 Section 93.122).

Use of the Version 2 model to support SIP air quality planning or transportation conformity analysis without remedying these problems threatens to lead to serious underestimation of mobile source emissions, years of additional unhealthy air quality (with attendant injury and premature death for many individuals), potential legal challenges to the region's transportation planning process, and unwise decisions about billions in transportation investments on the basis of faulty analysis. We urge you to take decisive, timely steps to assure that TPB and MWAQC will rapidly develop analysis tools

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[2] September 19, 2001, see http://www.mwcog.org/trans/inducedtravel.html.

[3] Metropolitan Washington Council of Governments, *Version 2.1/TP+ Travel Model Calibration Report*, Draft October 4, 2002, Washington, DC. Page 9-8

with adequate integrity so the public can trust your accounting. This means setting a standard of excellence that strives for state-of-the-art, rather than business-as-usual, state-of-the-practice transportation and impact analysis tools. Corporate boards and audit committees must assure sound accounting methods and honest reporting on corporate activities or face a devaluation of corporate integrity and public or shareholder trust and value. So too must TPB and MWAQC insist on sound accounting for transportation impacts.

Request for TPB and MWAQC Action. We urge you to oppose efforts to further study the Techway or Western Transportation Corridor bridge and highway proposals in light of the findings of our study, confirming those of prior studies which have shown these proposals to be unsound ideas that benefit only sprawl developers while harming the region's citizens, environment, and established communities. We also urge you to take immediate steps to fix serious accounting problems in TPB's transportation and emissions analysis models by assuring that the TPB Version 2 model will be upgraded to appropriately reflect induced traffic effects so it can be used to fairly appraise the impacts of alternative transportation and land use policies in our region. We also urge your timely action to shift additional transportation resources to investments that will reduce sprawl, traffic, and pollution, and to protect funding for such projects by including them in the region's State Implementation Plan for Air Quality.

Sincerely,

Michael Replogle
Environmental Defense

Dolores Milmoe
Solutions Not Sprawl

Neal Fitzpatrick,
Audubon Naturalist Society of the Central Atlantic States

Lee Epstein
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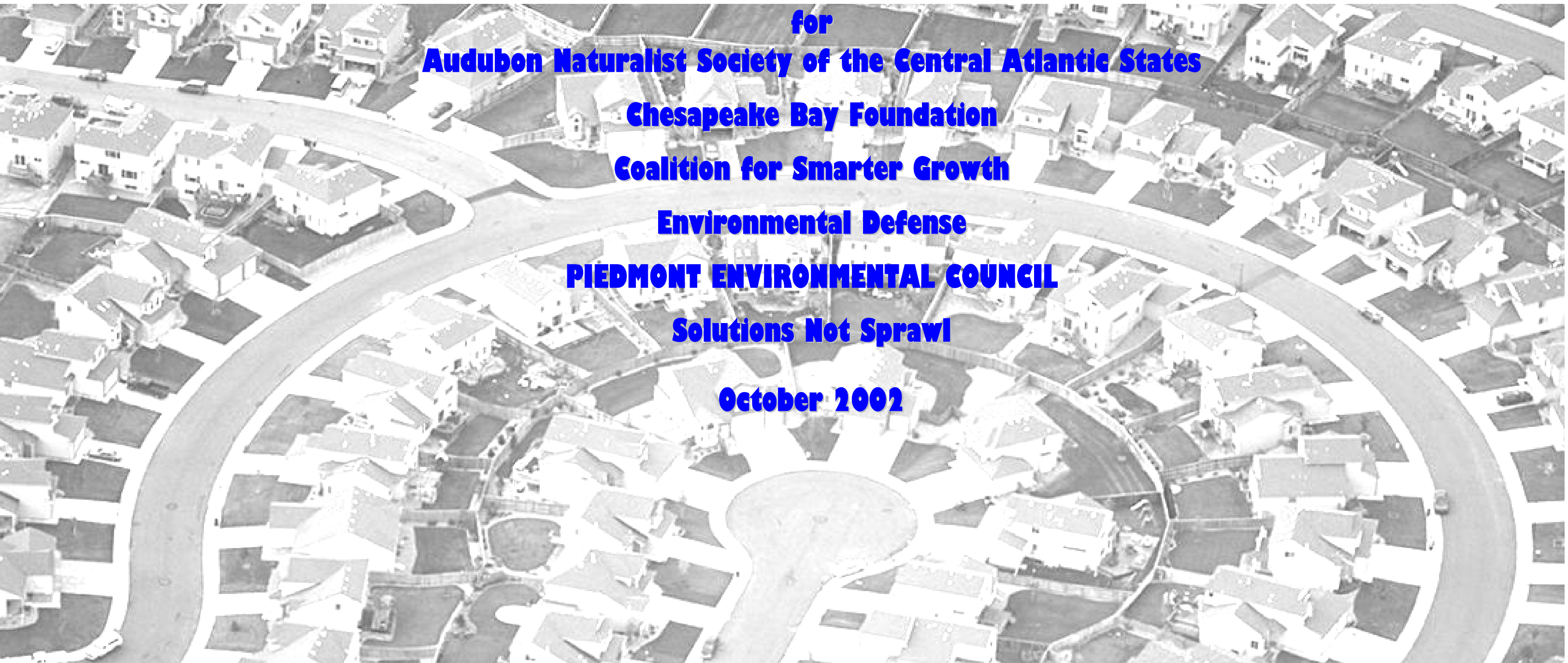
cc: Kanathur Srikanth, Chair, TPB Technical Committee
George Cardwell, Chair, TPB Travel Forecasting Subcommittee
Phil Andrews, Chair, MWAQC Technical Advisory Committee
Julie Pastor, Chair, COG Planning Director's Technical Advisory Committee
Jane M .Kenny, Regional Administrator, EPA Region 2
Nelson Castellanos, Division Administrator, FHWA Maryland Office
Roberto Fonseca-Martinez, Division Administrator, FHWA Virginia Office
Gary Henderson, Division Administrator, FHWA DC Office
Susan E. Schruth, Regional Administrator, FTA
Rep. Frank Wolf, Rep. Elect Chris Van Hollen
Sen. Mikulski, Sen. Sarbanes, Sen. Warner, Sen. Allen

More Sprawl, More Traffic, No Relief: An Analysis of Proposed Potomac River Crossings

Technical Report of research completed by:

Smart Mobility, Inc.



for

Audubon Naturalist Society of the Central Atlantic States

Chesapeake Bay Foundation

Coalition for Smarter Growth

Environmental Defense

PIEDMONT ENVIRONMENTAL COUNCIL

Solutions Not Sprawl

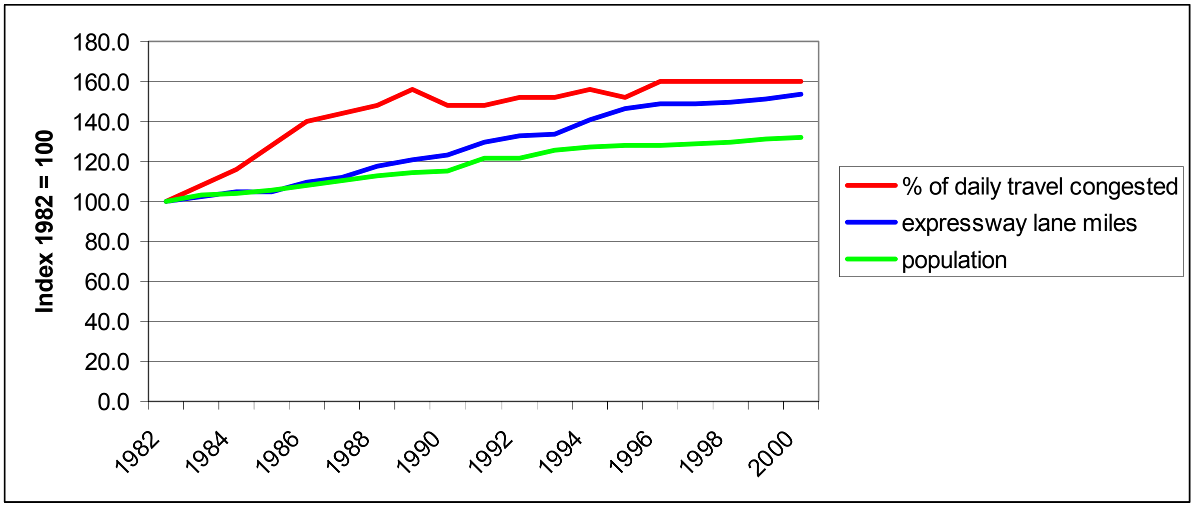
October 2002

INTRODUCTION

The Washington region is considering several alternatives for a new expressway Potomac River crossings west of the beltway. Before investing in any of these projects, it is critical that citizens understand what has happened in past efforts to reduce traffic congestion through highway construction, and what will likely happen in the future. This report documents land use changes and traffic impacts that would result from different possible new Potomac River crossings west of the beltway. In each case, the new roadways will bring additional development, and additional traffic. The traffic benefits of any of these alternative highways will be small, and outweighed by the costs.

Despite billions of dollars of investments in suburban expressways, congestion has increased in every major metropolitan area in the U.S. over the past twenty years. In the Washington D.C. region, expressway capacity has increased much faster than population growth, without any success in alleviating traffic congestion.

Figure 1: Expressway Investments Have Failed to Reduce Congestion in the Region



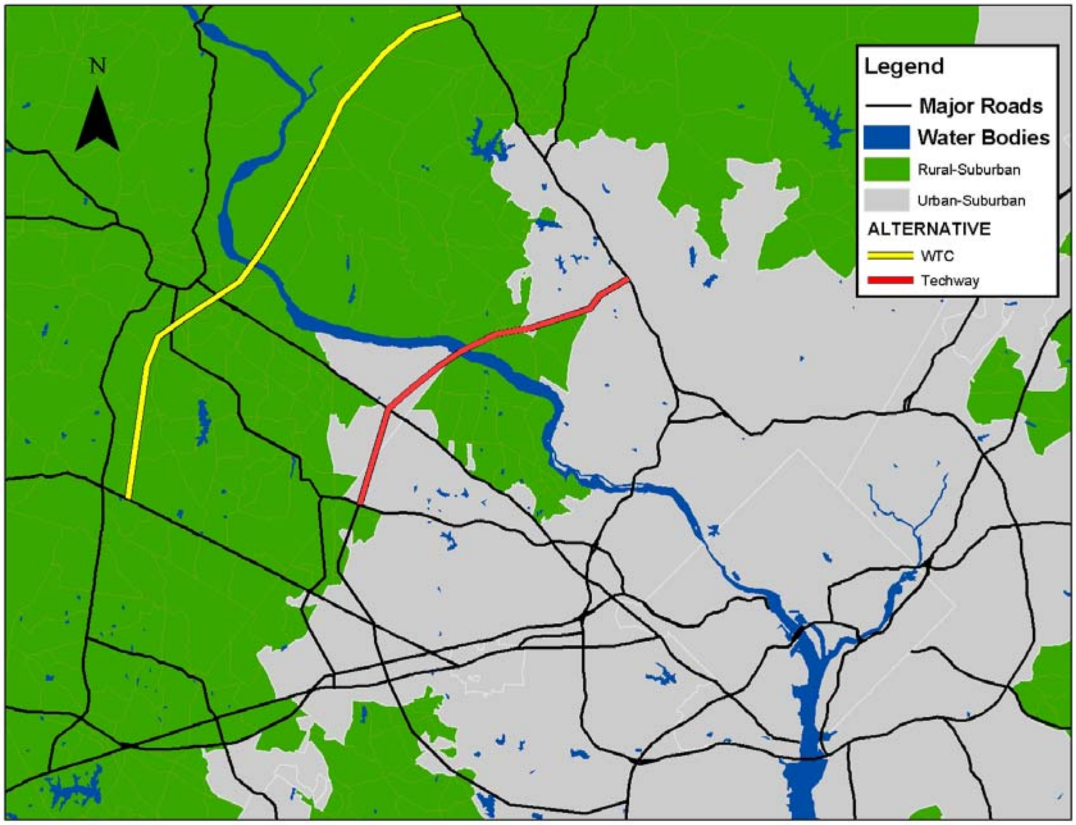
Texas Transportation Institute *Urban Mobility Study* data for the Washington D.C. region

New and widened suburban expressways have failed to live up to their promise. Sprawling development has followed the expressway projects, and expressways have filled with traffic much faster than planners assumed. Travel begins at homes and businesses. No trip begins or ends on an expressway, and the increased expressway traffic has spilled over onto intersecting roadways, creating many new bottlenecks. Expected traffic decreases on other roadways often have failed to occur at all.

The history of widening I-270 in Montgomery County, Maryland in the late 1980's demonstrates all these failings. Traffic conditions improved briefly. Then land development boomed in the corridor. "In the five years before construction began, officials endorsed 1,745 new homes in the area stretching from Rockville to Clarksburg. During the next five years, 13,642 won approval." (*Washington Post*, January 4, 1999) By 1997, I-270 was routinely overrunning its designed capacity, and peak-hour traffic volumes on some segments had surpassed levels forecasted for 2010.

This report analyzes traffic impacts that would result from different proposed expressway projects shown in Figure 2 below.

Figure 2: Proposed New Expressway/Potomac River Crossings



Different alignments have been proposed for the roadways. The WTC as modeled would cross the Potomac east of Leesburg. The Techway as modeled would cross the river near the Fairfax/Loudoun County line.

The following sections describe:

- how the regional travel demand model was used to forecast travel
- model enhancements for more accurate river crossing estimates,
- future land use forecasts, and
- resulting changes in traffic volumes and patterns.

TRAVEL DEMAND MODEL AND ENHANCEMENTS

The Metropolitan Washington Council of Governments (MWCOG) and its National Capital Region Transportation Planning Board (TPB), which serves as the region's Metropolitan Planning Organization (MPO) is developing a new version of its travel demand model. The Draft Version 2.0 model released to us on March 25, 2002 will be referred heretofore in this report as the "DCV2 model." The DCV2 model uses the TP+ transportation modeling software, and includes a number of changes that have been made to various modules which make up the traditional four-step travel demand modeling process as compared with previous versions of the TPB model.

The TPB intends to couple a slightly refined version of the DCV2 model, which was released in October 2002 as the "Version 2.1 model", with the EPA's new mobile source emissions factor model, MOBILE6. The joint travel demand and mobile source emission models will be used for future air quality conformity analyses of the D.C. region's Transportation Improvement Program (TIP) and the Constrained Long-Range Plan (CLRP) as well as for transportation project evaluations.

Our review of the DCV2 model has revealed deficiencies in assumptions and methods which have serious implications for air quality planning, the traffic projections for an additional Potomac River bridge, and other transportation project analyses.

Some of the key deficiencies in the DCV2 model include:

1. An extensive set of K-factors and time penalties is used during trip distribution
2. The number and length of vehicle trips estimated by the model is inconsistent with National Person Transportation Survey data
3. The distribution feedback mechanism is only applied to home-based work trips
4. The gravity model is not converging due to coding errors in the trip distribution TP+ script file

TIME PENALTIES AND K-FACTORS

A key part of modeling travel behavior is joining trip origins and trip destinations. This is accomplished in the trip distribution step of the travel demand model using a gravity model. The gravity model is named because it is analogous to the theory of gravitation. The attractiveness of a potential origin-destination pair is positively related to the number of trips at each end, and negatively related to travel time. "K-factors" and time penalties are sometimes used to adjust the relative attractiveness of possible origin-destination pairs.

The DCV2 model has more than 42 K-factors and 356 income-level time penalties in the trip distribution step for home-based work (HBW), home-based shopping (HBS), home-based other (HBO), and nonhome-based (NHB) trip purposes. In addition, there are also 114 K-factors for the medium and heavy truck trip purposes. Time penalties and K-factors ranging from 0.5 minutes to 15 minutes are used to restrict travel between certain zone pairs in the model. Available modeling tools can not always replicate observed travel behavior when psychological and/or historical elements are at work, which is often the case with natural barriers such as rivers. In these cases, K-factors are sometimes used to better match bridge volumes and/or model calibration. In the assignment step, the DCV2 model includes 14 bridge penalties of 5 minutes each on all of the Potomac River bridges. However, the time penalties and K-factors implemented in the TPB gravity model simply add time to inter-county trips and trips between Washington D.C. and the surrounding regions. Most disturbing is the use of time factors for intra-county trips, where there is no physical or socioeconomic reason that these factors should be necessary.

Although the use of K-factors may improve model results in the base year, it also forces future model scenarios to be similar to the base year, thereby limiting model sensitivity. Furthermore, they often address symptoms that really should be treated more systematically, by using more accurate methods to assure that trip rates, trip length distributions, and average auto occupancy values are all correct. The standard textbook on travel demand modeling is *Modeling Transport* by Ortúzar and Willumsen. Their guidance on K-factors is:

> *The best advice that can be given in respect of K-factors is: do not use them. If a study area has a small number of zone pairs (say, less than 5% of the total) with a special trip making association which is likely to remain in the future, then the use of a few K-factors might be justified, sparingly and cautiously. But the use of a model with a full set of Kfactors cannot be justified.*[1]

We believe that the best case for K-Factors in the Washington region can be made for State-to-State movements (considering D.C. as another “State”). In these cases, taxation can be different, affecting both work and shopping trips. Other trips can be linked to those trips.

We have removed all the income-level time penalties from the trip distribution step in the Enhanced Model, and replaced the TPB K-factors with a more limited set. For each of the six trip purposes, three “State” specific K-factors are applied during trip distribution. A K-factor value of 1800[2] is applied for all trips from the D.C. region to the D.C. region (TAZs 1-319). A K-factor value of 1400 is applied for all trips internal to the State of Maryland (TAZs 320-1229). The final K-factor is also equal to 1400 for trips internal to the Sate of Virginia (TAZs 1230-2144). K-factors are used in the gravity model to increase the attraction power of certain traffic analysis zones. As such, the K-factors we have specified make border-crossing trips less attractive than a trip that begins and ends in one of three regions defined above.

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[1] Ortúzar, Juan de Dios and Luis G. Willumsen. *Modeling Transport 3rd Edition,* p. 193. New York, NY: John Wiley and Sons, 2001.

[2] TP+ K-Factors are in implied thousandths; therefore 1800 is equal to a multiplier of 1.8.

NUMBER OF TRIPS AND TRIP LENGTHS

Even with more realistic K-factors, the model consistently over-predicted the number of Potomac River crossings. We began to suspect that the DCV2 model was not accurately predicting the number of trips and/or the trip lengths.

In order to understand this discrepancy with the DCV2 model, we compared the estimated number of vehicle miles of travel (VMT) against the vehicle miles of travel from corresponding base year traffic counts. The estimated VMT is calculated by multiplying the modeled link volume by the link distance. Traffic counts are not available for every link in the model. However, where count data is available, the count VMT is calculated by multiplying the count volume by the link distance. Table 1 below shows estimated 1994 daily VMT and corresponding count VMT according to the count range (a proxy for facility type).

Table 1: Daily 1994 VMT – Estimated versus Count

Count Range	Estimated VMT	Count VMT	% Difference
0 - 20,000	61,383,259	54,216,970	13%
20,000 - 40,000	29,351,014	29,494,240	0%
40,000 - 60,000	9,986,070	9,515,490	5%
60,000 - 80,000	4,923,946	5,196,100	-5%
80,000 - 100,000	8,728,344	9,421,070	-7%
100,000 – 120,000	8,823,471	9,866,850	-11%
120,000 – 140,000	208,882	290,920	-28%
Total	123,404,986	118,001,640	5%

As seen in Table 1, the DCV2 model assigns too many vehicles to the low class facilities which have count volumes under 20,000 vehicles per day. The estimated volume on these roadways is 13 percent too high. In addition, the model is under-assigning vehicles to the high class facilities which have count volumes greater than 100,000 vehicles per day. The estimated volumes on the two high class facility types are 11 percent and 28 percent low respectively when compared against the count VMT. The evidence in Table 1 suggests that the DCV2 model is estimating too many trips and that on average the trips are too short.

These suspicions were confirmed when we compared DCV2 model results against data extracted from the National Person Transportation Survey (NPTS) for the D.C. region. Table 2 shows the number of daily vehicle trips from the 1994 DCV2 model and 1995 NPTS.[1]

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[1] The 1995 NPTS sample for the Washington region includes 798 households which are weighted by household size, race, ethnicity, and month of response. This sample size is sufficiently large to estimate regional totals as is done here. A larger sample size is necessary for subpopulation estimates. However, TPB is no longer using their household survey data directly. In the most recent model work, they arbitrarily increase the number of non-work trip productions by 50 percent over the survey results, which they say addresses "underreporting of short non-work trips" (*Version 2.1/TP+ Travel Model Calibration Report Draft,* October 4, 2002). The 1995 NPTS made a major effort to remove undercounting and is a good source to check this assumption.

Table 2: Daily 1994 DCV2 Model versus 1995 NPTS[1] Vehicle Trips

Trip Purpose	1994 DCV2 Model	NPTS	% Difference
HBW	2,981,260	2,197,943	36%
HBS	2,265,846	1,517,079	49%
HBO	6,012,558	4,049,528	48%
NHB	5,106,981	4,029,594	27%
Total	16,366,645	11,794,145	39%

When compared against the NPTS, the DCV2 model predicts 36%, 49%, 48%, and 27% too many trips for HBW, HBS, HBO, and NHB trips respectively. Therefore, the trip rates being applied during trip generation are too high and/or the auto occupancy factors being applied to the number of person trips prior to assignment are too low. Trip generation is accomplished via a FORTRAN program written by MWCOG staff. Because modifying this program and estimating new trip rates and auto occupancy factors is outside our scope of work, we factored the number of trips (by purpose) produced by the DCV2 model. Prior to the highway assignment step in the model chain, the HBW, HBS, HBO, and NHB trip purposes in the final vehicle trip table are factored to yield totals consistent with the NPTS data.

Having reduced the number of vehicle trips, we then needed to lengthen trips. Once again, we compared the DCV2 model results against data extracted from the NPTS for the D.C. region. Table 3 shows the average trip length (in miles) by trip purpose.

Table 3: Average Vehicle Trip Lengths - DCV2 versus NPTS

Trip Purpose	DCV2 Average Trip Length (miles)	NPTS Average Trip Length (miles)	% Difference
HBW	15.29	16.04	-5%
HBS	4.79	5.71	-16%
HBO	5.55	8.82	-37%
NHB	6.63	8.64	-23%

As suspected, vehicle trip lengths in the DCV2 model are too short, especially for non-work trips. We derived and implemented a new set of friction factors for each trip purpose that replicate the observed trip length distances extracted from the NPTS database. Table 4 shows the number of vehicle trips produced by the Enhanced Model as a result of the pre-assignment step trip purpose factoring. Table 5 shows the average vehicle trip lengths that result from the new set of friction factors we have applied in trip distribution. In both cases, the results from our Enhanced Model replicate the NPTS data. The percent differences in the number of trips are within 1 percent, and the trip lengths are within 5 percent.

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[1] The NPTS region is not identical to the TPB region; therefore the NPTS numbers shown were developed by scaling the NPTS numbers with the population ratio between the two regions.

Table 4: Daily 1994 Vehicle Trips – Enhanced Model versus NPTS

Trip Purpose	Enhanced Model	NPTS	% Difference
HBW	2,173,041	2,197,943	-1.1%
HBS	1,529,584	1,517,079	0.8%
HBO	4,051,617	4,049,528	0.1%
NHB	3,998,996	4,029,594	-0.8%
Total	11,753,238	11,794,145	-0.3%

Table 5: Average Vehicle Trip Lengths – Enhanced Model versus NPTS

Trip Purpose	Enhanced Model Ave Trip Length (miles)	NPTS Ave Trip Length (miles)	% Difference
HBW	16.50	16.04	2.9%
HBS	5.63	5.71	-1.4%
HBO	9.16	8.82	3.9%
NHB	8.47	8.64	-2.0%

DISTRIBUTION FEEDBACK

The 1990 Clean Air Act Amendments (CAA) have placed new emphasis on the outputs of transportation forecasting procedures and their sensitivity to travel reduction or congestion reduction strategies. This in turn has focused more attention on “feedback” in the traditional four-step travel forecasting process to ensure that the methods properly account for congestion that does exist and its impact on travel and location decisions.

The U.S. Environmental Protection Agency’s guidance on the preparation of emissions inventories (U.S. EPA, 1992) describes feedback as a necessary part of the travel forecasting process and in fact footnotes that the U.S. District Court of Northern California ruled that “where the model had the capability to incorporate feedback affects, the planning agency was obliged to project travel with those effects included.” It also emphasized that:

> *EPA considers that the feedback effect between trip assignment and the trip origin/destination is the most important at this time, given the current state of modeling practice and the potential for model improvement that incorporating such effects may have. The link travel times used for trip distribution should be consistent with the results of the trip assignment step.*

To put it simply, distribution feedback is required by the 1990 CAA in the preparation of emissions inventories and air quality conformity determinations. The Code of Federal Regulations Title 40 Section 93.122 which describes the procedures for determining regional transportation-related emissions states:

> *Zone-to-zone travel impedances used to distribute trips between origin and destination pairs must be in reasonable agreement with the travel times that are*

> *estimated from final assigned traffic volumes. Where use of transit currently is anticipated to be a significant factor in satisfying transportation demand, these times should also be used for modeling mode splits.*

The TPB DCV2 model does include distribution feedback. However, the feedback mechanism is only applied to home-based work trips. Specifically, AM congested times are used to distribute HBW trips while off-peak uncongested times are used to distribute HBS, HBO, and NHB trips. The underlying assumption by TPB staff is that congestion does not influence non-work trip making. More should be done to ensure that the zone-to-zone travel times used to distribute trips are in agreement with the travel times resulting from assignment.

In a publication by the Travel Model Improvement Program (TMIP) – a program sposored by the EPA and U.S. DOT – entitled *Incorporating Feedback in Travel Forecasting: Methods, Pitfalls, and Common Concerns* dated March 1996, the authors provide technical guidance on incorporating feedback in the traditional four-step model. Some of the findings published in the report are summarized below:

> *The implementation of the assignment-distribution feedback can produce different system-wide travel characteristics when there is congestion in the modeled networks. This result suggests that feedback may be essential to accurately forecast travel when congestion exists.*
>
> *The mix of trips during the congested periods of the day should determine the trip purposes for which feedback should be investigated. Feedback should be implemented for the work-related trips at a minimum, and the other purposes should be examined for their percentage of peak travel.*

Table 6 shows the number of 1995 NPTS vehicle trips by trip purpose and time period from the Enhanced Model. Table 7 shows the same data as percentages of the total number of trips in the period.

Table 6: 1995 NPTS Vehicle Trips by Purpose and Time of Day from Enhanced Model

Time Period	HBW	HBS	HBO	NHB	Total
AM Peak	744,709	103,197	609,176	361,035	1,818,177
PM Peak	705,992	392,283	987,148	1,051,491	3,136,914
Off-Peak	722,340	1,034,104	2,455,293	2,506,470	6,798,207

Table 7: Percent of Vehicle Trips by Purpose and Time of Day

Time Period	HBW	HBS	HBO	NHB	Total
AM Peak	41%	6%	34%	20%	100%
PM Peak	23%	13%	31%	34%	100%
Off-Peak	11%	15%	36%	38%	100%

In the AM Peak period, home-based work trips are the highest proportion of total vehicle trips, representing 41 percent, but represent less than half of all trips. In the PM Peak period home-based work trips are not even the highest fraction of total trips. In the PM Peak period, there are more home-based other and nonhome-based trips representing 31 percent and 34 percent of the total vehicle trips respectively. Although TPB may argue that only home-based work trips are influenced by congestion, the mix of trips during the peak periods determines the trip purposes for which feedback should be implemented. Therefore, in the Enhanced Model we distribute all trip types with the AM congested times, not just HBW trips, thereby allowing the feedback mechanism to function for the non-work trips as well.

GRAVITY MODEL CODING ERROR

Trip distribution is the process of estimating the number of trips that will travel between all zones in the network. Usually the process uses the number of trip ends in each zone as the starting point. These marginal totals are distributed to the rows and columns of a generated trip matrix. The most commonly used distribution process is the "gravity" model.

The gravity model equation ensures that the correct number of trips will be distributed for each production zone; the row (production zone) totals for each will always match the number of productions for the zone. However, there is no guarantee that the correct column totals (number of attractions) will be obtained for each attraction zone. The estimated column values usually do not match the desired number of attractions calculated for each zone during trip generation. This is corrected for by iterating the gravity model. After each iteration, the estimated column totals are compared to the desired attractions. Based upon the comparison, the process is repeated with an adjustment in the data. The iteration process is repeated until the results are deemed close enough, or that a maximum number of iterations have been performed. The module stops when one of two conditions is satisfied. These conditions are specified using two parameters in TP+, MAXITERS and MAXRMSE.

MAXITERS specifies that no more than a maximum specified number of iterations are to be performed. The default in TP+ is 3, and the maximum allowed is 99. The DCV2 model is only performing 3 iterations of the gravity model because of a coding error in the TP+ trip distribution script file “Trip_Distribution.s” In the DCV2 script, the maximum number of iterations is specified with the following code:

```
MAXITRS = 7                   ; specify GM iterations to be 7 to be consistent with
                         ; prior MINUTP runs
```

The parameter call is missing the letter "E" in MAXITERS. As such, TP+ is not recognizing this parameter initialization and is doing the default number of gravity model iterations (3). It is unlikely the gravity model is converging with only three iterations. The Enhanced Model is using the maximum number for MAXITERS, 99.

The module also computes the root mean square error (RMSE) of the differences in estimated versus desired attractions. If the computed RMSE is less than MAXRMSE, the gravity model is terminated. The DCV2 model uses the default MAXRMSE setting which is 10. The minimum value accepted by TP+ is 0.0001. Considering the computation time necessary to run the DCV2 model, we have reset this parameter to 1 in order to produce better convergence of the gravity model. Setting the MAXITERS and MAXRMSE parameters as described above ensures that the gravity model will converge.

BASE YEAR VALIDATION

As the model will be used to evaluate different proposed Potomac River bridge alignments, an important objective in making these modifications to the DCV2 model was to improve the model's performance in estimating Potomac River crossings. Screenline 20 in the DCV2 model represents the Beltway and 'Inner' Potomac River crossings. The reported 1994 daily traffic count for screenline 20 is 892,000 vehicles. The reported volume estimated using the DCV2 TP+ model is 965,000 vehicles. Therefore, the DCV2 model overestimates the number of river crossings in 1994 by 8 percent. Our model reduces the number of 1994 daily river crossings to 936,561 vehicles per day. This volume is only 5 percent higher than the traffic counts.

Following our analysis of the Version 2.0 model, MWCOG released Version 2.1 and draft documentation dated October 4, 2002. In the *Draft Calibration Report*[1], Exhibit 8-3 shows that the estimated 1994 volume for screenline 20 has increased to 1,090,000 vehicles per day. Therefore, the Version 2.1 model overestimates the number of river crossings in 1994 by 22 percent, an increase of 14 percent against the Version 2.0 model. As such, the Enhanced Model performs better than both the Version 2.0 and 2.1 models in estimating Potomac River crossings.

In addition to improving the Potomac River crossings screenline, our modifications have also improved the overall performance of the model on the other screenlines analyzed by TPB. In the Enhanced Model, 20 of the 35 screenlines show improvement over the DCV2 model (i.e. the ratio of estimated to observed volume is closer to 1). The DCV2 model volume is 8 percent too high. The inner screenlines subtotal (yellow) is 2 percent too low in the Enhanced Model, while the DCV2 model is 9 percent too high. The outer screenlines subtotal (blue) also favors our model which is only 4 percent high instead of the DCV2 model which is 16 percent too high. Most importantly, the grand total of all the screenline volumes (orange) for the Enhanced Model is only 2 percent low. The DCV2 model volume is 10 percent too high when all screenline volumes are summed.

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[1] Metropolitan Washington Council of Governments. *Version 2.1/TP+ Travel Model Calibration Report Draft,* October 4, 2002.

Table 8: Screenline Analysis – DCV2 Model versus Enhanced Model

Screenline	DCV2 Volume	Enhanced Volume	Ground Count	Est/Obs DCV2	Est/Obs Enhanced
1	726,000	643,616	802,000	0.91	0.80
2	942,000	809,961	915,000	1.03	0.89
3	921,000	856,553	866,000	1.06	0.99
4	973,000	841,810	966,000	1.01	0.87
5	1,220,000	1,069,896	1,078,000	1.13	0.99
6	1,733,000	1,496,134	1,591,000	1.09	0.94
7	1,224,000	1,02,291	1,154,000	1.06	0.89
8	1,567,000	1,359,784	1,368,000	1.15	0.99
9	668,000	645,603	598,000	1.12	1.08
10	276,000	267,859	230,000	1.20	1.16
11	168,000	153,055	156,000	1.08	0.98
12	505,000	435,602	472,000	1.07	0.92
13	395,000	362,995	370,000	1.07	0.98
14	308,000	256,109	318,000	0.97	0.81
15	245,000	203,979	238,000	1.03	0.86
16	204,000	168,874	214,000	0.95	0.79
17	435,000	368,698	390,000	1.12	0.95
18	645,000	568,110	544,000	1.19	1.04
19	488,000	459,918	466,000	1.05	0.99
20	965,000	936,561	892,000	1.08	1.05
22	1,427,000	1,252,880	1,196,000	1.19	1.05
23	168,000	166,788	136,000	1.24	1.23
24	440,000	427,707	444,000	0.99	0.96
25	103,000	122,187	78,000	1.32	1.57
26	399,000	383,145	256,000	1.56	1.50
27	308,000	319,408	290,000	1.06	1.10
28	143,000	144,983	108,000	1.32	1.34
Inner Subtotal	17,596,000	15,743,506	16,136,000	1.09	0.98
31	139,000	149,559	58,000	2.40	2.58
32	90,000	84,335	54,000	1.67	1.56
33	281,000	250,549	226,000	1.24	1.11
34	113,000	108,616	94,000	1.20	1.16
35	819,000	703,532	782,000	1.05	0.90
36	66,000	58,437	28,000	2.36	2.09
37	27,000	26,524	24,000	1.13	1.11
38	136,000	123,077	174,000	0.78	0.71
Outer Subtotal	1,671,000	1,504,629	1,440,000	1.16	1.04
Grand Total	**19,267,000**	**17,248,135**	**17,576,000**	**1.10**	**0.98**

Table 9: Screenline Analysis – DCV2.1 Model versus Enhanced Model

Screenline	DCV2.1 Volume	Enhanced Volume	Ground Count	Est/Obs DCV2.1	Est/Obs Enhanced
1	817,000	643,616	802,000	1.02	0.80
2	1,120,000	809,961	915,000	1.22	0.89
3	965,000	856,553	866,000	1.11	0.99
4	1,133,000	841,810	966,000	1.17	0.87
5	1,202,000	1,069,896	1,078,000	1.12	0.99
6	1,749,000	1,496,134	1,591,000	1.10	0.94
7	1,245,000	1,02,291	1,154,000	1.08	0.89
8	1,606,000	1,359,784	1,368,000	1.17	0.99
9	679,000	645,603	598,000	1.14	1.08
10	252,000	267,859	230,000	1.10	1.16
11	163,000	153,055	156,000	1.04	0.98
12	548,000	435,602	472,000	1.16	0.92
13	420,000	362,995	370,000	1.14	0.98
14	327,000	256,109	318,000	1.03	0.81
15	286,000	203,979	238,000	1.20	0.86
16	255,000	168,874	214,000	1.19	0.79
17	437,000	368,698	390,000	1.12	0.95
18	627,000	568,110	544,000	1.15	1.04
19	485,000	459,918	466,000	1.04	0.99
20	1,090,000	936,561	892,000	1.22	1.05
22	1,461,000	1,252,880	1,196,000	1.22	1.05
23	176,000	166,788	136,000	1.29	1.23
24	447,000	427,707	444,000	1.01	0.96
25	101,000	122,187	78,000	1.29	1.57
26	382,000	383,145	256,000	1.49	1.50
27	298,000	319,408	290,000	1.03	1.10
28	109,000	144,983	108,000	1.01	1.34
Inner Subtotal	18,380,000	15,743,506	16,136,000	1.14	0.98
31	127,000	149,559	58,000	2.19	2.58
32	86,000	84,335	54,000	1.59	1.56
33	292,000	250,549	226,000	1.29	1.11
34	94,000	108,616	94,000	1.00	1.16
35	834,000	703,532	782,000	1.07	0.90
36	72,000	58,437	28,000	2.57	2.09
37	26,000	26,524	24,000	1.08	1.11
38	119,000	123,077	174,000	0.68	0.71
Outer Subtotal	1,650,000	1,504,629	1,440,000	1.15	1.04
Grand Total	**20,030,000**	**17,248,135**	**17,576,000**	**1.14**	**0.98**